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1.2.1 1.2.1: Detecting, quantifying and characterizing nanomaterials

Task Lead TOLAYMAT, THABET M
Lab/Center NRMRL
Division LRPCD
Start Date Qtr: 1 FY: 2012
End Date Qtr: 4 FY: 2016
Project 1.2: Nanomaterial-Specific Inherency Issues
Task Description
The increasing use of nanomaterials in various products makes their release into the environment inevitable. Methodologies for the detection, quantification and characterization of these nanomaterials are thus essential in order to investigate their environmental impacts. Currently, there are some techniques for the detection and characterization of □pure□ nanomaterials□ suspensions. However, the characterization and detection of nanomaterials becomes complicated in environmental samples that may contain impurities, colloids and organic materials that may interfere with the detection of these nanoparticles. Having the ability to detect, quantify and characterize these nanomaterials in various environmental systems is of a great importance to the EPA as it facilitates the risk assessment and leads to more comprehensive evaluation of the use of nanomaterials in new products.
Research Approach
Research gap with regards to analytical capabilities for the detection quantification and characterization of nanoparticles has resulted in the identification of this research as a priority for ORD. New and existing analytical methods will be developed and refined to measure and evaluate quantities and characteristics of these nanoparticles in environmental media. These methods would also allow, in the case of metallic nanoparticles, for distinguishing metal ions from the metallic forms. Additionally these methods would assist in the identification of the specific nanomaterials inherent properties that affect their release, transport, and fate in the environment, as well as their potential exposure and adverse effects on human health which will lead to a more comprehensive risk evaluation. Under this research effort, a set of effective methodologies for detection, quantification and characterization of nanomaterials in environmental media and biological tissues will be developed using an array of laboratory-based and field screening techniques. Laboratory methods will employ advanced separation methods such as field flow fractionation (FFF) and hydrodynamic chromatography (HDC), as well as pioneering detection approaches such as single particle-inductively coupled plasma mass spectrometry (SP-ICPMS) and liquid cell atomic force microscopy (AFM) for characterizing nanomaterials in environmental samples. Analytical methods for quantifying chemical composition and speciation will include new synchrotron based high resolution micro/nano-X-ray fluorescence and adsorption spectroscopy capable of quantifying elemental chemical state and binding environments at the nanoscale and micro X-ray photoelectron spectroscopy. Leading edge sample preparation techniques for electron microscopy (EM) will allow for the first time sensitive and representative nanomaterials detection, quantification, and characterization. Remote detection and characterization of nanomaterials in the subsurface will be investigated using advanced geophysical techniques. There is a relatively large number of nanoparticles that are currently being used and their applications are expected to grow exponentially. Of these nanoparticles, four have been identified as the short-term focus of this research effort. These nanoparticles are copper (CuNPs), silver (AgNPs), cerium oxide (Ce2O) and carbon nanotubes (CNTs). Copper and silver nanoparticles are of importance because of their strong antibacterial properties which resulted in their increasing incorporation in many consumer products such as textiles, plastics and lumber. Cerium oxide is heavily used as a fuel additive with little information about its environmental fate. Finally, carbon nanotubes (CNTs) exhibited some toxicological impacts that have to be evaluated in various environmental settings. It is expected that the long-term nanoparticles specific focus of this research effort will change to address EPA□s research needs as a result of new advancements in and changes to nanomaterials applications. As a result, the focus may shift away from these nanoparticles (as more data about them is gathered) to include others that are of interest to the Agency.

FTE Estimates (+) (For Planning Purposes Only) [2]

Funding Estimates (+) (For Planning Purposes Only) [2]

Stakeholder Needs Met [0]

Expected Outputs (-) [3]

Description: Nanoparticles in the environment: Methods for the detection and characterization to analyze metal and carbon-based nanoparticles in environmental matrices.
Decision/Actions:
Format: OTHER
Expected Qtr: 4 **FY:** 2016

Description: Fate of nanoparticles in the environment: Data on the impacts of inherent particle properties and environmental conditions on their fate in environmental systems.
Decision/Actions:
Format: OTHER
Expected Qtr: 4 **FY:** 2016

Description: Leaching of nanoparticles from products: Data on the quantities and speciation of nanoparticles leaching from consumer products containing nanomaterials.
Decision/Actions:
Format: OTHER
Expected Qtr: 4 **FY:** 2016

Expected Products (-) [9]

Description: (6) Report characterizing Cu NP leached from treated wood.
Recipients:
Niva Kramek (OCSPP)
Kathleen Raffaele/OSWER
Carl Mazza/OAR
Thomas Carpenter/SAB
Product Type: PUBLISHED REPORT
Subtype: REPORT
Delivery Date: FY2013
Date Delivered: **On Time?:** Y

Description: (11) Development of methods that detect, quantify, and characterize metal-containing nanoparticles in environmental samples with two-dimensional separation techniques in response to clients needs for development of analytical methodology.
Recipients:
Niva Kramek
Product Type: OTHER
Subtype:
Delivery Date: FY2014
Date Delivered: **On Time?:** Y

Description: (10) Development of laboratory and field tests, advanced analytic techniques (XPS, HR-TEM, FESEM, etc) and quantum chemistry calculations to evaluate the applications, implications and potential risks of surface-altered TiO2, CNT, Cu, ZnO and Ag nanoparticles from consumer products in environmental vectors (landfills, soil, chlorinated and brackish water, biosolids, and wetland).
Recipients:
Niva Kramek
Product Type: OTHER
Subtype:
Delivery Date: FY2014
Date Delivered: **On Time?:** Y

Description: (8) Development of methods that uses advanced analytic techniques (XPS, HR-TEM, FESEM) and quantum chemistry calculations to characterize the size, surface charge and agglomeration state of CNT in the presence of environmental stressors for toxicological studies.
Recipients:
Niva Kramek
Product Type: OTHER
Subtype:
Delivery Date: FY2014
Date Delivered: **On Time?:** Y

Description: (5) Evaluation of characterization of the size and mixing state of ambient cerium containing particles from fuel additives based on observations and modeling.
Recipients:
Carl Mazza/OAR
Kathleen Raffaele/OSWER
Niva Kramek
Product Type: OTHER
Subtype:
Delivery Date: FY2013
Date Delivered: **On Time?:** Y

Description: (4) Characterize and Assess Ag nanomaterial surface property effects on fate in Containment Systems.
Recipients:
Niva Kramek (OCSPP)
Kathleen Raffaele/OSWER
Carl Mazza/OAR
Thomas Carpenter/SAB
Product Type: OTHER
Subtype:
Delivery Date: FY2013
Date Delivered: **On Time?:** Y

Description: (3) Analytical method for characterizing nano particles by hyphenated techniques with deterction by single particle ICP mass spectrometry
Product Type: OTHER
Subtype:
Delivery Date: FY2013

Recipients:
Niva Kramek (OCSPP)
Kathleen Raffaele/OSWER
Carl Mazza/OAR
Thomas Carpenter/SAB

Date Delivered: **On Time?:** Y

Description: (2) Develop methods for characterizing the physical and chemical properties that influence bioavailability of nano silver.

Product Type: OTHER
Subtype:
Delivery Date: Q4 FY2012
Date Delivered: **On Time?:** Y

Recipients:
Kathleen Raffaele /OSWER

Description: (1) Evaluation of rotating disk technology as a method for separation of nanomaterials in environmental matrices.

Product Type: OTHER
Subtype:
Delivery Date: Q4 FY2013
Date Delivered: **On Time?:** Y

Recipients:

Collaborators (-)
Internal Collaborators (known or proposed)

People:
WILLIS, ROBERT D
ROGERS, KIM R
BRADHAM, KAREN D
NELSON, CLAY M
DENNE, JANE E
JONESLEPP, TAMMY L
ROSAL, CHARLITA G
HEITHMAR, EDWARD M
SOVOCOOL, G W
MOMPLAISIR, GEORGESMARI
VARNER, KATRINA E
WERKEMA, DOUGLAS D
PYE, HAVALA O
SCHENCK, KATHLEEN M
TOLAYMAT, THABET M
ALABED, SOUHAIL R
LUXTON, TODD P

Programs:
SHC

Organizations:
ORD/NERL/HEASD
ORD/NRMRL
ORD/NERL/AMD
ORD/NERL/ESD
OSWER

External Collaborators (known or proposed)
TBD

Milestones (-) [9]

Description: 3.1 SOP on in-vitro methods for the determination of the estimated bioavailability of AgNPs.
Interim Activities:
Comments:
Scheduled Qtr: 2 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 4.2 Initial Development of hyphenated techniques for characterizing nanoparticles with detection by single particle-inductively coupled plasma mass spectrometry.
Interim Activities:
Comments:
Scheduled Qtr: 3 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 4.3 Draft evaluation of rotating disk technology for nanomaterial sampling.
Interim Activities:
Comments:
Scheduled Qtr: 4 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 4.4 Draft methodology outlining hyphenated techniques for characterizing nanoparticles with detection by single particle-inductively coupled plasma mass spectrometry.
Interim Activities:
Comments:
Scheduled Qtr: 2 **FY:** 2013
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 5.1 Draft report and data on the impact of AgNPs in waste composting systems.
Interim Activities:
Comments:
Scheduled Qtr: 4 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 6.1 Completion of ambient field sampling of cerium oxide in Newcastle, UK.
Interim Activities:
Comments:
Scheduled Qtr: 3 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 7.1 Micronized copper treated lumber sample collection and methodology finalization.
Interim Activities:
Comments:
Scheduled Qtr: 2 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 7.2 Develop and evaluate methods for measuring copper ions and nanoparticles in leachates from treated wood products.
Interim Activities:
Comments:
Scheduled Qtr: 3 **FY:** 2012
Completed Qtr: **FY:**
Is this milestone on track?: Y

Description: 7.3 Draft report and data on the mobility of micronized copper from treated lumber.
Interim Activities:
Comments:
Scheduled Qtr: 3 **FY:** 2013
Completed Qtr: **FY:**
Is this milestone on track?: Y

Facilities Needed [0]

Categories (+) [1]

Suggestions/Feedback?